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ABSTRACT

This publication, the sixth of seven booklets intended for adult education teachers of students with learning disabilities, reviews assessment and remediation considerations in mathematics. Observation of math disabilities is discussed in terms of social and general academic environment, calculation activities, quantitative concepts, and applied problem solving. The remediation section lists instructional suggestions for specific difficulties in calculation (such as remembering math facts and correctly sequencing multidigit numbers), concept learning (including understanding mathematical symbols, remembering and reading mathematical abbreviations, and generalizing quantitative concepts), and applied problem solving (such as using correct operations, sequencing solution steps, organizing problem data, and determining whether the solution is correct). Following a brief discussion of the role of calculators a list of materials and references is provided. (CL)

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Academic Assessment and Remediation of Adults with Learning Disabilities:

A Resource Series for Adult Basic Education Teachers

ASSESSMENT AND REMEDIATION OF MATHEMATICS

Five County Adult Education Program
(Barrow, Clarke, Jackson, Oconee, and Oglethorpe Counties)
Clarke County Board of Education
Athens, Georgia 30601

1984

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PREFACE

All adults who have not completed high school are potential clients for our Adult General Education Program and are aggressively recruited. Most of them with motivation proceed normally through our instructional program until they reach their goal. While following the progress of our students, we observed that some of them made slower progress and gained lower than expected achievement levels. These students did not reach their goal or our goal for them, although many had good motivation, seemed alert and bright, and occasionally made excellent progress in one or more skills. An awareness grew that a significant number of the students might be learning disabled.

Assistance was at hand from the University of Georgia, Department of Special Education, in the persons of Dr. Cheri Hoy and Dr. Noel Gregg, who met with the staff of the project for planning, worked with our adult education teachers in workshops, as well as wrote our project publications. Our appreciation is also expressed to the teachers of the five-county program for their participation, to Mrs. Betty Westbrook, Athens, for her extra-hours typing of the manuscripts, to Ms. Shelby Johnson, Snellville, for editorial assistance, and to Dr. Edward T. Brown, Stone Mountain, for facilitating the development and production processes.

Dr. Janie Rodgers
Project Director

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ASSESSING MATHEMATICS DIFFICULTIES

Adults who lack basic mathematics skills often have difficulty functioning independently. While they might obtain a job, they may be unable to manage their financial affairs without some assistance. Problems handling routine banking and purchasing tasks may place these adults in a position of continued dependency. Similarly, adults lacking basic mathematics skills often become dependent on others for help with tasks requiring measurement such as cooking, building and home maintenance. Such a position may cause a negative self-concept and low motivation.

Adult education teachers often work with students who have problems with mathematics. Some problems are a function of instructional weaknesses, low intelligence, post motivational problems, or inability to read. However, some students might be experiencing problems with mathematics because of an underlying processing problem which makes learning mathematics especially difficult. These students are learning disabled.

The adult education teacher already has good instruments and procedures for assessing arithmetic computation skills. These can also be used with students suspected of having learning disabilities, being aware, however, that any student may have adequate computational skills but still have trouble applying those skills in practical problem-solving situations. Determining whether or not these difficulties are due to a learning disability is more complicated. Such difficulties in application might be related to deficits in oral language, visual processes, or reasoning abilities. Assessing these deficiencies requires the systematic manipulation of the input/output level

of response and task demands which can identify the poor learning responses to be disability based.

The cognitive factors that may influence mathematics performance are:

oral language ability

long and short term memory

verbal reasoning

nonverbal reasoning

reading ability

visual-spatial skills

organizational skills

Observations for Assessing Math Disabilities

There are many situations in the academic environment which deal with quantitative concepts. These can include measurement, estimating, logical progression, manipulating or using numbers, knowing number facts, and understanding mathematical processes. Whenever error is consistent either in one of the concept areas or across several of them, a program of observation should be structured to establish its persistence and its mathematical base. Once the suspicion of disability is aroused, difficulties with quantitative concepts in any type of activity should be investigated, as well as difficulties in calculation, learning quantitative concepts, and applying mathematic knowledge. A learning disability may exist if the student has difficulty in handling quantitative relationships. These are some observations to make.

Observations in the social and general academic environment, difficulty with:

1. making change
2. judging the size of objects
3. maintaining a checkbook
4. reading maps and diagrams
5. estimating travel time
6. learning and remembering multiplication tables
7. remembering the steps in long division
8. understanding part/whole relationships
9. learning and using measurement and/or time concepts
10. developing and utilizing problem-solving strategies

Observations during calculation activities, difficulty with:

1. remembering basic math facts
2. remembering the procedure for regrouping
3. aligning calculation problems
4. performing consistently on timed versus untimed tests of basic math facts
5. sequencing correctly multidigit numbers (i.e., 356 for 365)

Observations while learning or using quantitative concepts, difficulty with:

1. understanding mathematical symbols
2. grasping measurement concepts
3. grasping time concepts
4. grasping space concepts
5. grasping part/whole relationships
6. remembering and reading mathematical abbreviations
7. generalizing quantitative concepts across different kinds of materials

Observations during applied problem solving, difficulty with:

1. using the correct operation to solve one-step story problems
2. correctly sequencing solution steps in multistep word problems
3. apply mathematical concepts to real world application situations (i.e., cooking, banking, etc.)
4. organizing problem data to find the solution
5. determining if the solution is correct

REMEDIATING MATHEMATICS DIFFICULTIES

The teacher who suspects that an adult student has specific processing deficits affecting mathematics must be able to take information gained during formal and informal assessment and translate it into instructional practices. It will take extensive planning to match appropriate teaching strategies to the information about the student's specific strengths and weaknesses. A mismatch between the student's abilities and the instructional approach can result in tremendous frustration for both teacher and student. Since many of the adults who come to adult education classes have experienced failure and frustration in the past, it is extremely important that all of the available information be used to make the current experience a successful one.

Reading skills, as well as the cognitive processes, are factors in learning and using mathematical skills. In most cases, reading skills must be upgraded first and care should be taken not to use mathematical materials which require reading beyond capability; mathematical materials of the correct level, however, can frequently be used for reading instruction and practice. In fact, the teacher should have a good idea of the student's language ability, memory skills, reasoning ability, as well as the specific strengths and weaknesses in mathematics before beginning instruction. Also, the student's purpose for learning mathematics can be a great source of motivation.

Many adult students had difficulty with mathematics in the past and have developed a mind-set against it. Their instructional objectives differ from an interest in passing the GED, brushing up before going to a junior college or technical school, or to just needing to improve functional skills so as to be independent. The instructional plan should initially concentrate on only

those objectives necessary for the student to obtain his or her goal and strong effort should be made to show the student how the material being covered relates to the goal. Once the initial goal has been gained, then the student can be urged to expand his mathematical efforts toward new objectives.

The mode of mathematics instruction for adults is individualized. Occasionally, however, a few students with similar needs and learning behavior can be grouped. In these instances, the teacher should explain his or her understanding of the common goal and how the instructional process has been organized to reach it. Each session should be divided into instruction and practice sessions. Students at the same approximate level and who work at approximately the same speed can be formed into study teams for the practice activity. This can sometimes provide a confidence building experience.

HOW TO USE THIS SECTION

The organization of this section parallels the organization of the first. Under the main headings of Calculation, Quantitative Concept Learning, and Applied Problem Solving the observations listed previously will be repeated with instructional suggestions listed under each observation. A word of caution: The suggestions here are only meant to help the teacher get started. Comprehensive instructional plans are not outlined here. For additional help, the teacher is referred to the list of materials which appears at the end of this booklet.

Calculation

Calculating involves both knowing and using correctly the basic mathematics facts and processes. It is also important for the student to understand them. Each fact and process must be consistently and accurately recalled from a base of automaticity which can only be developed through practice and drill. Comments and instructional suggestions for each difficulty follow.

Difficulty remembering basic math facts

Problems in this area may be the result of having never really learned the basic facts in the past. If this is the case, the student should first develop a table of the basic facts for personal study and use. Then with teacher help or study materials the student should focus on the "patterns" which can be found in the tables. After "discovering" the patterns, the student should have a lot of drill activities so he or she will develop an automaticity for recalling the basic facts.

In other cases the student has been taught the basic facts but severe memory problems prevent recall of them when they are needed. In such cases the memory deficit may be indicative of a learning disability. Even with considerable drill these students may not be able to develop the automatic recall that they need to efficiently solve larger problems. For these students it is important to circumvent the memory problem by providing them with charts of the basic facts so they can develop an understanding of more complex problem situations. After developing such an understanding, these students may need to use a calculator to circumvent their memory problems. (Calculators will be discussed at the end of this section.)

Some students can remember basic facts if they are in isolation (i.e., 9 - 6 =) but cannot recall the fact if it is embedded into a larger problem (i.e., 495 - 361 =). Such a problem may be related to difficulties

distinguishing figure-ground relationships. In these cases it is helpful to train the student to take the smaller problem out of the context of the larger problem, work the smaller problem on the side, and then return to the larger problem.

Difficulty remembering the procedure for regrouping

Regrouping procedures (i.e., "borrowing" and "carrying") are often difficult for students. As with the basic facts, some students have not learned the procedures or have developed some that are erroneous. The teacher should have the student work several problems requiring different types of procedures to determine the breakdown in the student's understanding. Developmental instruction should then begin at the point of the breakdown. Such instruction may have to include lessons on place value and may require the student to solve problems with concrete materials on a place value chart.

Other students can readily explain the regrouping steps as long as the teacher is nearby and asking structured questions. These students understand the regrouping procedures but have not developed them to the automatic level. Some of these students merely need more drill work to reinforce what they know. However, students with memory problems may not show much improvement despite repeated drills. It is important not to frustrate these students by requiring them to use memory skills they do not have. Rather, have the student develop small index card reminders of the regrouping procedures. They should then be allowed to use these cards when solving problems.

Difficulty aligning calculation problems

Learning disabled individuals who have visual spatial deficits often have difficulty aligning problems properly. Misalignment of problems then leads to calculation errors. Sometimes the individual can, with tremendous effort,

properly align the first several problems, but as fatigue and overload develop have difficulty aligning later problems. Such difficulties are sometimes misinterpreted as a deterioration of the student's effort and concentration. For the learning disabled adult, this is not the case. To circumvent the visual spatial deficits, the student should be allowed to work problems on graph paper so the columns of squares can provide the needed external structure. If graph paper is not available, standard notebook paper can be turned sideways so the lines form columns.

Students with visual spatial deficits may make calculation errors even if the problems are already written for them. These students may have difficulty "tracking" down a single column of numbers. They inadvertently use numbers from other columns and therefore miscalculate. To circumvent this type of problem, the student should be given several highlighter markers of different colors. Prior to calculating the student should highlight the first column of numbers to be used. When finished with that column, the student can highlight the next column in a different color.

Discrepancy between timed versus untimed tests

Timed tests assess a student's automaticity or speed with which he or she can recall information that has been previously learned. Often poor performance on a timed test indicates that the student must have more practice to develop efficiency with a computational procedure. Some learning disabled students may understand the procedures they need to use but perform poorly on timed tests because of deficits in the speed with which they process information. During untimed testing situations these students often perform much better. This improved performance is in contrast to the consistently poor performance of the underprepared student. When it is suspected that poor performance on timed tests are caused by deficits in the speed of processing information,

similar tests can be administered both timed and untimed. Should a discrepancy in performance exists, it might indicate that a disability exists and an adjustment based on the student's mathematical goals should be made. In some cases the timed test may be inconsistent with the student's needs and should be omitted. If the student is trying to prepare for an exam in which time will be a factor, the teacher needs to assist the student in obtaining an evaluation which will confirm or refute the presence of an underlying deficit indicative of a learning disability. A student who has a documented speed of processing deficit can often request a modification of timed exams. Such a modification does not make the exam easier for this student than for the others who do not have modifications. Rather, it allows the student to circumvent his or her disability and compete on equal footing with the other nondisabled students.

Difficulty correctly sequencing multidigit numbers

At some time or another, and especially under pressure, almost all students will accidentally missequence a multidigit number (i.e., 356 for 365). However, such missequencing may be indicative of a specific learning disability if it happens on a fairly regular basis. Little can be done to correct the deficit which results in the missequencing. It is most important, however, to help the student develop an awareness of the problem and to develop strategies for circumventing the problem. The teacher and student together can keep records to help determine if the missequencing occurs with all multidigit numbers or only certain types (i.e., four digit but not three digit) on certain types of problems, or in certain types of situations. The student should develop a habit of always checking for a missequencing error before considering his or her work completed.

Quantitative Concept Learning

Deficits in this area are marked by almost no understanding of mathematics principles and concepts, mechanical performance of simple math processes that have been reduced to rote, and an inability to estimate or judge quantitative relationships. Related to this lack of understanding of concepts are difficulties in understanding mathematical symbols, remembering and reading mathematical abbreviations, and generalizing from the quantitative concepts. Comments for each of these follow.

Difficulty grasping concepts

Some learning disabled students have an especially difficult time developing an understanding of concepts related to measurement, time, space and part/whole relationships. Despite well-sequenced developmental and remedial instruction, these adults continue to have trouble with situations involving these concepts. The difference between these learning disabled adults and adults with low intelligence is that the learning disabled adult's difficulty seems incongruous with his or her almost normal functioning in other academic and vocational areas. Often both the teacher and the learning disabled student become frustrated because there seems to be no good reason why this otherwise normally functioning adult should have so much difficulty with very basic concepts. In such cases, it is important to help the adult develop compensation strategies which will enable him or her to function. Adults with severe deficits interfering with the attainment of certain spatial and measurement concepts should receive career counseling which will direct them to occupations not requiring those skills. Once some compensation strategies are developed, mathematical instruction should focus on other areas in which the student will have more success. When the student feels comfortable about the progress made in other areas, brief developmental lessons

using these difficult concepts can be tried. Such lessons should be structured around an applied problem.

Difficulty understanding mathematical symbols

Many times students learn mathematical symbols during instruction designed to develop concepts. Some students, however, have extreme difficulty learning symbols in an incidental manner while concepts are developed. Frequently, these students have had difficulty learning to attach meaning to a variety of symbols. They may have had an especially hard time learning to read. They may have had trouble learning the meaning of environmental symbols such as those used on highway signs or directories. These students will require direct instruction on the meaning of symbols and the provision of many exercises and much practice in which the student must pick the number sentences which mean the same thing:

a. 20/5	b. 20 - 5	c. 20 ÷ 5
a. 4 + 3	b. 4 x 3	c. 4(3)

Some students may have visual discrimination deficits which make it difficult to notice the difference in problems with similar looking mathematical symbols. On a page of mixed problems the student may not perform the correct operation because he or she has not noticed that some signs mean add (+) and others mean multiply (x). These students must be made highly aware of their tendency to make this type of error and to make a habit of monitoring for it after each mathematical task. The student can also be helped to develop circumvention strategies such as circling all of one type of problem, solving those problems, and then solving the other type of problem.

Difficulty remembering and reading mathematical abbreviations

For the learning disabled adult, difficulty remembering and reading mathematical abbreviations is often directly related to problems with reading. The instructional suggestions given in the reading booklet for developing vocabulary should be used with the mathematical content words and abbreviations.

Difficulty generalizing quantitative concepts

Some learning disabled adults have particular difficulty with flexibility of thought. This difficulty often makes it hard for the adult to use his or her knowledge in a variety of settings. Therefore, it is extremely important that concepts are introduced and developed in applied problem situations and that the adult have experience using the concept with a variety of materials. For example, when teaching fractional concepts, each can be presented in measurement situations (both solid and liquid). These situations provide the real world context which will help the generalizability of the concepts. It will also help to continually relate the instructional process to the context in which the student is likely to ultimately use the information.

Applied Problem Solving

The teaching principles for transfer of training should be recalled and used with all students who have difficulty in this area. Additional effort should be made to base remedial instruction on problem applications leading to the goal of the student; life problems or vocational, if this is where mathematic skills will be used, GED type problems if the goal is to pass this examination. Comments and instructional suggestions follow for each difficulty cited in the assessment section.

Difficulty using the correct operation

Students who have difficulty using the correct operation to solve applied problems often do not see the connection between the concepts they have learned and the application of those concepts. Some of these difficulties can be avoided if the concepts are introduced and developed in applied problem situations. However, for some students, application of math concepts to real world situations will remain difficult even when the concepts are introduced in applied settings. Some of these students experience such difficulties because of language deficits which interfere with understanding the situations that are often presented either verbally or in writing. This problem is not adequately addressed by merely teaching "cue" words which signal a particular operation in a story problem. As the student begins working more complex problems, cue words will not be a reliable strategy. Rather, the teacher should prepare lessons which focus separately on the language of the problem, the various steps and processes to be used and the order of their use, the performance of the calculations, and only finally on the solution. Ideas for sample lessons follow:

1. Give the student a set of data and have the student write several different types of story problems using the data.
2. Give the student a set of data and an answer. Have the student write the question which goes at the end of the data set and which would match the given answer.
3. Give the student word problems in which the student must apply a missing word in order for the problem to make sense. Example: Lola earned $155 at the end of the first week of work. She (earned, spent) $45 over the weekend. Now she has $110.

Difficulty sequencing solution steps

Memory deficits or problems manipulating several variables are both factors which may make it difficult for the student to sequence the solution steps in a problem. To circumvent memory problems, the student can be encouraged to make and use cue cards which list the procedural steps for various types of problems. For students experiencing problems for other reasons, exercises in which the solution steps are given in mixed order can be prepared and the student can then merely order the steps. As students become proficient in these types of activities, they can be given problems which contain some, but not all, of the solution steps. The student would then have to sequence those steps which are given and supply the missing steps.

Difficulty applying mathematical concepts

Students often experience problems applying mathematical concepts because the concept was initially introduced as an abstraction. Application difficulties can be prevented many times by using real life situations for the introduction of the concept. These should be followed by using a variety of application situations so the student does not develop a rigid notion of how the concept can be used. Team problem solving can often be used to help reduce the anxiety of working real world problems.

Difficulty organizing problem data

Students who have had a history of failure in mathematics are frequently overwhelmed by applied problems. Often they have developed inappropriate solution strategies such as always adding all of the numbers even when the problem calls for subtraction or division. These inappropriate strategies have usually been reinforced during their school years when story problems were used primarily as computational exercises after the introduction of a computational

procedure. Real life problems, the type with which the student will be faced, are not usually presented in the organized fashion of most school story problems. Therefore, students often have not had experiences which required locating and organizing mathematical data. It is frequently advantageous for the adult education teacher to facilitate the student's ability to handle real life problem situations by providing the student with structured lessons requiring the organization and location of data. Suggestions follow:

1. Give the student problems containing extraneous information and the problem solution. Have the student review the problem and solution, and then identify the extraneous information.
2. Give the student problems containing extraneous information and an outline of the solution steps. Have the student identify the extraneous information and then solve the problem as outlined.
3. Give the student problems which are missing some information needed to solve the problem. Give the student several choices of needed information and have the student select the appropriate choice and solve the problem.
4. Give the student problems which are missing some information needed to solve the problem. Have the student state where the missing information might be located.
5. Give students working in problem solving teams large, real life problems (i.e., balancing a checkbook when checks are missing, planning a family budget, etc.) which require that a great deal of data be organized. Initially, it may be necessary to give the students an outline which will help them organize the information. With practice, however, the students may be able to organize the information without the outline.

Difficulty determining if the solution is correct

Students who are frustrated or anxious about mathematics are so relieved when they have concluded a problem they pay little attention to whether the obtained answer is reasonable. Many times these students lack estimation skills which are needed for checking the reasonableness of an answer. These suggestions can give them the teacher-directed practice in estimation that they need.

1. Beginning with relatively easy computation problems have students state whether the answer should be larger than any of the single numbers in the problem or smaller than at least one of the given numbers. At first have the student solve the problem to check the hypothesis. Later have the student state why he or she gave the answer given before solving the problem. These activities should become part of the regular practice sessions.
2. Give the student problems which are followed by multiple choice options which help with estimation. Have the student select the correct choice and then solve the problem to check his or her answer. Example: Lola earned $155 at the end of the first week of work. With overtime she earned $186 at the end of the second week. How much has she earned to date? The answer will be:

   (a) over $500 (b) under $186 (c) slightly more than $300
3. Give the student practice in rounding numbers and then making an estimate of the answer to problems based on the rounded numbers.

CALCULATORS

Students who have difficulty with mathematics can be taught to use the calculator as a circumvention aid. Calculators can be incorporated into adult basic education classes in such a way that they can enhance the regular instruction. When the purpose of a lesson is to provide drill on a computational procedure, the students should not use calculators initially. However, after completing the assigned problems, the students can double check their own work with a calculator. Such checking will force the student to examine his or her own work in a manner which would not take place without the calculator. This sort of activity also makes the student a more independent learner.

When drill is not the objective of the lesson, students can use calculators so that their attention is on the solution process rather than worrying about their recall of basic facts. Using calculators in these situations allows the student to work problems which are more like those occurring naturally. Therefore, lessons are more realistic and more motivating.

It should never be assumed that a student knows how to use a calculator. Each student should be checked, given whatever instruction is needed, and then given practice activities to gain facility and confidence. If possible, the initial instruction should involve printing calculators so the student can check the accuracy of their data entries.

MATERIALS

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Real Life Math Series. Chatsworth, CA: Opportunities for Learning, Inc.

Checking Account and Budgeting. Chatsworth, CA: Opportunities for Learning, Inc.

Target Vocational Math. Chatsworth, CA: Opportunities for Learning, Inc. The following titles are included in this series of work-test books:

Mathematics for Employment

The Consumer in the Supermarket

The Consumer in the Department Store

Mathematics for Family Living

Mathematics for Citizenship

Mathematics for Everyday Living

Mathematics for the Worker

Mathematics for Adult Living

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Titles in this series:

Description and Definition of Learning Disabilities
Appraisal and Assessment of Learning Disabilities
Assessment and Remediation of Oral Language
Assessment and Remediation of Written Language
Assessment and Remediation of Reading
Assessment and Remediation of Mathematics
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